AIR SERVICE INFORMATION CIRCULAR

(AVIATION)

PUBLISHED BY THE CHIEF OF AIR SERVICE, WASHINGTON, D. C.

Vol. IV	July 1, 1922	No. 358

STATIC TEST OF THE LOENING PA-1 SINGLE-SEATER PURSUIT AIRPLANE

(AIRPLANE SECTION, S. & A. BRANCH)

▽

Prepared by
D. B. Weaver
Engineering Division, Air Service
McCook Field, Dayton, Ohio
April 10, 1922

(II)

STATIC TEST OF THE LOENING PA-1 SINGLE-SEATER PURSUIT. PLANE.

SUMMARY OF RESULTS.

Airplane: Loening PA-1; A. S. No. 64247.
Type: III.
Total weight: 2,461 pounds.
Wing cellule weight: 309 pounds.
Wing area: 282.5 square feet.
Engine: Wright Radial, 350 horsepower.

Description: The Loening PA-1 is a single-seater pursuit biplane. The U. S. A.-27 aerofoil is used. Estimated maximum speed at ground, 140 miles per hour. Wings are constructed of wood and fabric, the fuselage of steel tube with wire bracing. Built by the Loening Aeronautical Engineering Corporation, New York.

RESULTS OF TEST.

Date.	Part tested.	Load required.	Pounds per square foot or factor supported.	Failed at.	Weight.	Failure.
Sept. 26, 1921	Horizontal stabilizer.	35 pounds per sq. ft.	50 pounds per sq. ft.	....	0.94 pounds per sq. ft.	
Do.......	Elevator.........	......do.......	41.5 pounds per sq. ft.	50 pounds per sq. ft.	0.75 pounds per sq. ft.	First diagonal rib outward from the control mast failed in bending.
Do.......	Elevator control.	......do........	....do.......	No failure...		Held satisfactorily.
Sept. 27, 1921	Vertical fin...... Rudder..........	30 pounds per sq. ft.	45 pounds per sq. ft.	47.5 pounds per sq. ft.	1.02 pounds per sq. ft.	Ribs failed in bending.
Do.......	Rudder control..	......do........	....do......	No failure...		
Oct. 1, 1921	Ailerons.........	35 pounds per sq. ft.	35 pounds per sq. ft.	...do......	0.76 pound per sq. ft.	Not carried to destruction.
Do.......	Aileron control wing cellule.	......do.......	15 pounds per sq. ft.	20 pounds per sq. ft.		Pulley bracket tore loose from wing spar.
Oct. 5, 1921	High incidence..	Factor 8.5...	Factor 9.....	No failure...		Wing held satisfactorily, but the fuselage longerons began to buckle at the points of support.
Oct. 4, 1921	Low incidence...	Factor 5.5...	Factor 5.5...	.....do.....		
Sept. 30, 1921	Reverse load....	Factor 3.5...	Factor 3.79..	.....do.....		
Oct. 12, 1921	Six foot length of leading edge.	Factor 14....	....	Factor 16.6..		
Oct. 10, 1921	Fuselage.........	Factor 7.....	Factor 7.....	Factor 7.5...	Bare 92.5 pounds.	Wire broke in second to last bay, left side, after holding 7.5 for 3 minutes.
	Tail skid........	....	....	....	....	
Oct. 4, 1921	Chassis:					
	Struts........	6.............	7.............	No failure...	....	Axle showed a permanent set at a factor of 6.5.
	Axle.........	5–5.5........	6.............	6.5..........		
	Shock absorber.	5.............	Fully extended at 7.			

Discussion.—Redesign aileron pulley bracket. Change method of attaching aileron pulley bracket to spar to prevent splitting of the spar. Redesign rib where aileron pulley bracket is attached.

OBJECT.

This static test was conducted for the purpose of determining the structural strength of the Loening PA-1 airplane submitted in accordance with contract No. 357, dated January 20, 1921.

DATE AND PLACE.

These tests were conducted at McCook Field, Dayton, Ohio.

WITNESSES.

Lieut. E. W. Dichman...All tests.
Lieut. C. W. Pyle........All tests.
Lieut. C. N. Monteith....Not present at empennage tests.
W. E. Savage.............All tests.
D. B. Weaver.............All tests.

GENERAL RECOMMENDATIONS.

Wing cellule—None.
Aileron—Redesign the lower rear spars, the aileron control cable pulley bracket, and replace the compression rib.
Empennage—None.
Fuselage—None.
Landing chassis—None.

GENERAL DESCRIPTION.

The Loening PA-1 is a single seater pursuit biplane, propelled by a 350-horsepower 9-cylinder air-cooled fixed radial Wright engine.

The estimated performance from tests on a wind tunnel model is 140 miles per hour at sea level.

Total weight......................... 2,461 pounds.
Disposable load.....................   922 pounds.
Total wing area...................... 282.5 square feet.
Weight per square foot of lifting surface 8.7 pounds.
Weight per horsepower................ 7.04 pounds.
Aerofoil............................. U. S. A.–27.

For front and side elevations, see Figure 1. For plan view, see Figure 2.

Figures 3 and 4 are photographs of the assembled airplane before it was static tested.

The list of armament and equipment is according to Air Service Specification No. 1,518–C.

This airplane was built by the Loening Aeronautical Engineering Corporation of New York City.

WING CELLULE.

DESCRIPTION.

The wing cellule consists of an upper and lower wing with an N–type interplane strut on each side. The flying wires are double and the landing wires are single.

Wing.	Area.
Upper.....................	144.5 square feet.
Lower.....................	138 square feet.

Figures 5 and 6 are assemblies of the upper and lower wing. They are built upon two routed spruce spars to which the type of rib shown in Figure 7 is attached. Cross sections of the wing spars are shown in Figure 8. The wing tips are made from one piece of balsa wood having a semicircular cross section with an outside radius at any point equal to one-half the aerofoil thickness.

The leading edge is covered with three-ply gum plywood and the wings completely covered with cotton fabric.

The interplane struts are made of mild steel tubing welded at the intersections, with balsa wood fairing, cemented and taped to the tube. Figure 9 is an assembly of the end strut.

The ailerons are on the lower wing only. Their movement is controlled by means of a flexible steel cable.

The wing cellule has a structural weight of 1.095 pounds per square foot.

PROCEDURE FOR TEST (REVERSE FLIGHT).

The airplane was assembled as for flight, so that the mean chord made an angle of 14 degrees with the horizontal, trailing edge down.

The center of gravity of the load was located at 25 per cent of the chord from the leading edge of the wing.

The load was applied according to the loading schedule (Fig. 10). After a load had been put on and supported for five minutes, deflection readings at 10 points along the spar were taken and the retreat of the wing tips measured as indicated in Figure 11.

RESULTS.

The wing supported the required factor of 3.5 satisfactorily. The bearing surface of the clip which connects the spar to the fuselage had crushed into the spar one-sixteenth

of an inch. For tabulated results and spar deflection curves, see Figures 11 and 12.

PROCEDURE FOR TEST (LOW INCIDENCE).

The airplane was set up in an inverted position so that the angle r between the wing chord and the horizontal was 14° 10', trailing edge down.

The angle of incidence α, of the wing at low incidence, and B the angle between the vertical and resultant air force, are determined from wind-tunnel data.

$$\angle \alpha = -2° - 48'.$$
$$\angle \beta = \cot^{-1} L/D = \cot^{-1} 4.97 = 11° - 22'.$$
$$\angle \gamma = \angle \beta - \angle \alpha = (11° - 22') - (-2° - 48') = 14° - 10'.$$

The center of pressure at a value of $\angle \alpha = -(2° - 40')$ is 60 per cent of the chord from the leading edge. The center of gravity of the load was located the same distance from the leading edge of the wing as the center of pressure.

The load was applied according to the loading schedule, Figure 13. At the points indicated in Figure 14, deflection and retreat readings were taken after each load increment had been supported for five minutes.

RESULTS.

Figures 14 and 15 give the spar deflections and wing tip retreat in tabulated form.

The required load factor of 5.5 was supported without failure.

PROCEDURE FOR TEST (HIGH INCIDENCE).

The airplane was reset so that the angle between the wing chord and horizontal represented by γ, was 10° – 10' leading edge down.

$$\alpha = 17° - 12'$$
$$\beta = \cot^{-1} L/D = \cot^{-1} 8.1 = 7° - 2'$$
$$\gamma = \alpha - \beta = 17° - 12' - 7° - 2' = 10° - 10'.$$

The center of gravity of the load was located at 29 per cent of the wing chord.

The loads were placed according to the loading schedule, Figure 16. Deflection and retreat readings were taken at points indicated in Figure 17, after each load increment had been supported for five minutes.

RESULTS.

Deflections of the wing spars and wing tip retreat are given in tabulated form, Figure 17. Figure 18 gives the wing spar deflection curves.

At a required factor of 8.5 the longerons began to bend at the point where the fuselage was supported.

At a factor of 9, the wings held the load satisfactorily, but the test was discontinued due to the weakness of the fuselage.

DISCUSSION.

The results of the tests made by the Material Section on the wing spars are as follows:

The moisture content of the spars was uniform and approximately what might be expected for the time of year.

The specific gravity of all the spars was above the minimum requirement of Air Service Specifications.

SPAN — — — 20·0"
CHORD — — — 5·4"
GAP — — — 4·9⅞"
STAGGER — — — 22¾"
LENGTH (OVER ALL) 19·9½"

LOENING PA-1
FRONT AND SIDE ELEVATION

FIG. 1.

AREAS
UPPER WING — 144·6 □'
LOWER WING — 138·0 □'
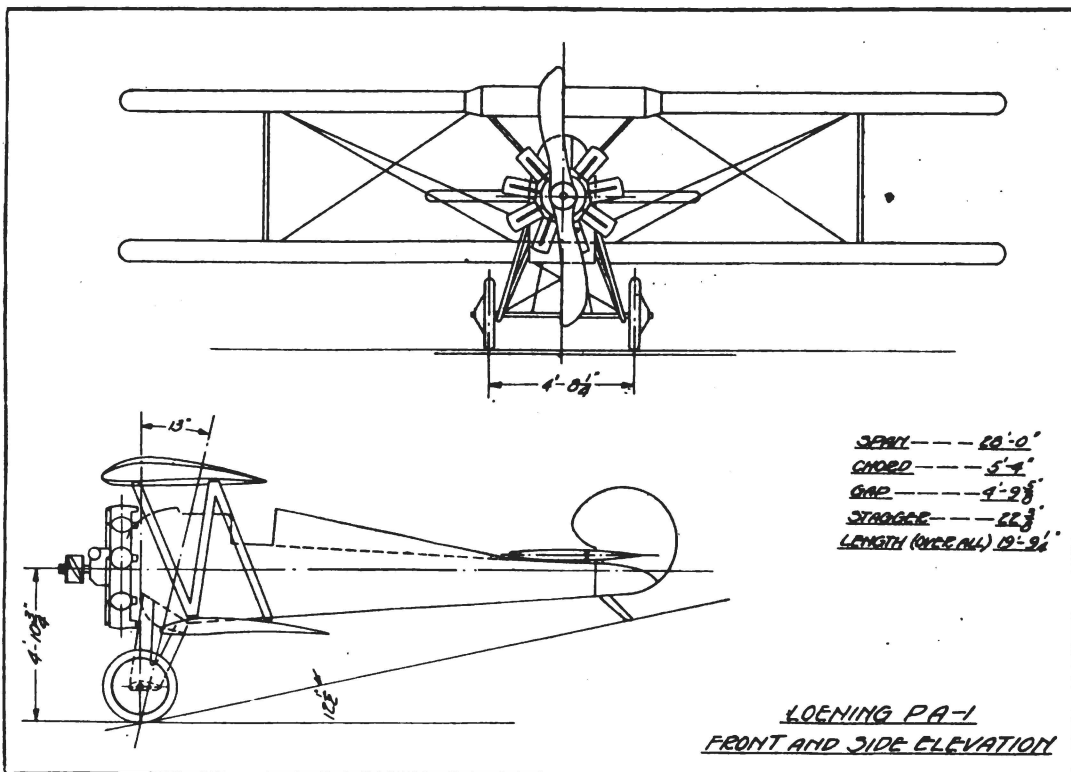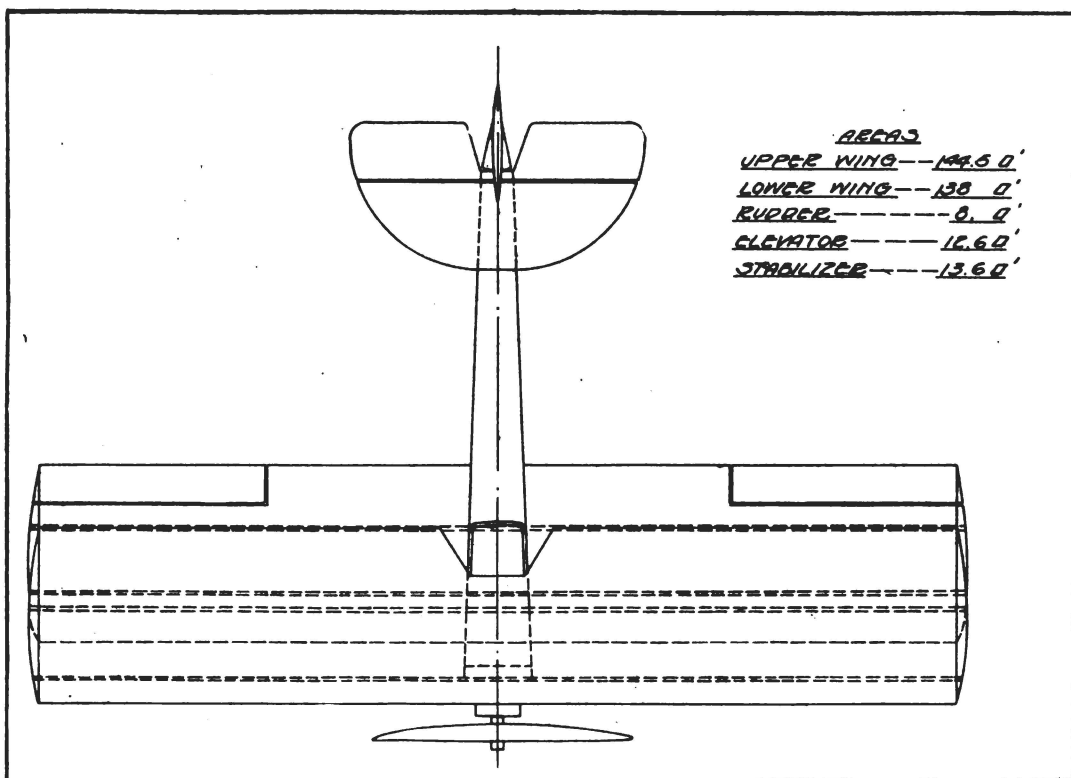RUDDER — — — 8·0 □'
ELEVATOR — — 16·6 □'
STABILIZER — — 13·6 □'

FIG. 2.—Loening PA-1, Wright Radial, 340 horsepower.

FIG. 3.

FIG. 4.

5

FIG. 5.

UPPER WING
LOENING PA-1

LOWER WING
LOENING PA-1

SECTION OF END FAIRING.

FIG. 6.

FIG. 7.—Typical wing ribs of the Loening PA-1.
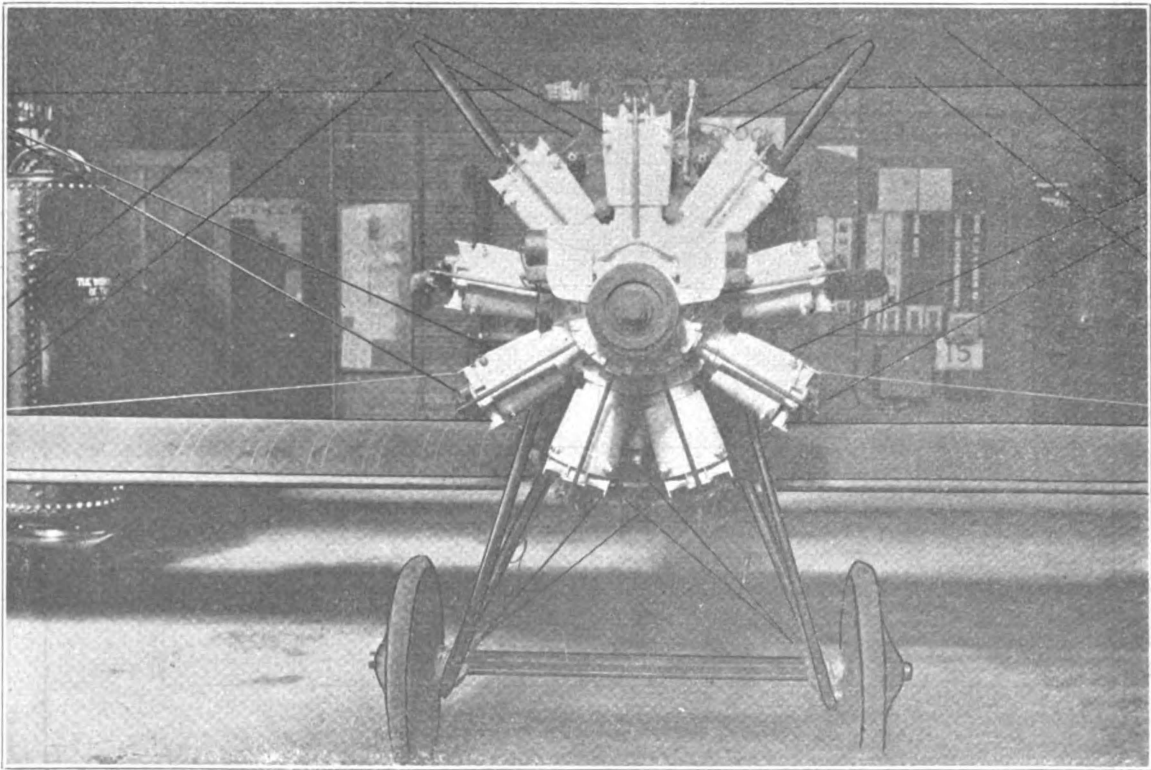
FIG. 8. Spar sections of the Loening PA-1.
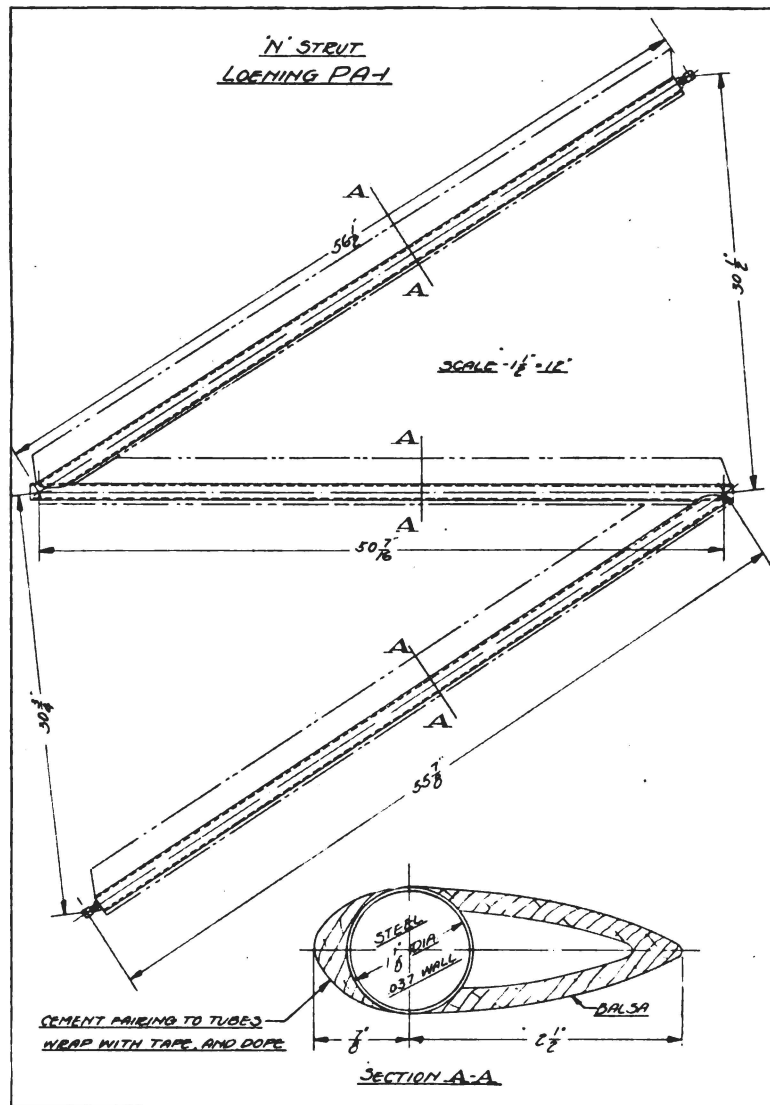
FIG. 9.
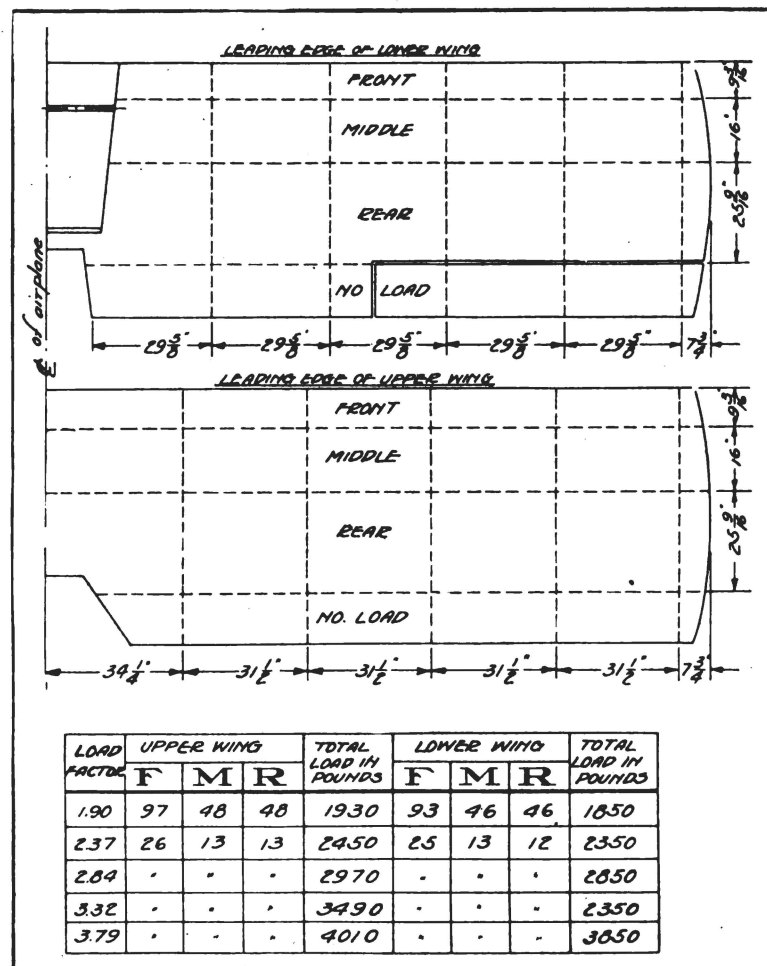
Fig. 10.—Loading schedule for the reverse load static test of the Loening PA-1.

LOAD FACTOR	UPPER WING F	M	R	TOTAL LOAD IN POUNDS	LOWER WING F	M	R	TOTAL LOAD IN POUNDS
1.90	97	48	48	1930	93	46	46	1850
2.37	26	13	13	2450	25	13	12	2350
2.84	.	.	.	2970	.	.	.	2850
3.32	.	.	.	3490	.	.	.	2350
3.79	.	.	.	4010	.	.	.	3650

LOAD FACTOR	DEFLECTION IN INCHES A	B	C	D	E	F	G	H	I	J	K	L	RETREAT LL	LU	RL	RU
1.90	.8	.8	.4	.3	.2	.3	.1	.1	-.2	.3	.5	.8	+.3	.0	-.4	-.4
2.37	1.2	1.1	.5	.3	.4	.4	.2	.1	-.2	.4	.7	1.2	+.3	.0	-.5	-.6
2.84	1.3	1.3	.7	.4	.3	.4	.1	.2	-.1	.6	.9	1.4	+.3	.0	-.4	-.7
3.32	2.0	1.6	.9	.4	.2	.4	.0	.1	-.1	.7	1.2	1.8	+.3	.0	-.6	-.9
3.79	2.4	1.7	1.0	.4	.3	.5	.2	.1	-.1	.7	1.4	2.1	+.3	.1	-.6	-1.0

Fig. 11.—Tabulated results of the reverse loading static test of the Loening PA-1.

FIG. 12.—Curves showing mean deflection of the wing spars at points indicated during static test for reverse flight condition on the Loening PA-1.

LOAD FACTOR	LOWER WING			TOTAL LOAD IN POUNDS	UPPER WING			TOTAL LOAD IN POUNDS
	F	M	R		F	M	R	
3	66	133	66	2640	87	176	87	3500
4	23	47	23	3570	31	61	31	4730
4.5	12	23	12	4040	15	32	15	5350
5.0	.	.	.	4510	.	.	.	5970
5.5	.	.	.	4980	.	.	.	6590

FIG. 13.—Loading schedule for the low angle of incidence static test of the Loening PA-1.

LEADING EDGE OF UPPER WING (INVERTED)

RU   F   E   D   C   B   A   LU
RL   LL
     L   K   J   I   H   G

LOAD FACTOR	DEFLECTION IN INCHES												RETREAT			
	A	B	C	D	E	F	G	H	I	J	K	L	LU	LL	RU	RL
3	.4	1.0	.1	.1	.5	.4	1.2	.6	.3	.5	.8	1.2	-.2	+.4	-.2	+.5
4	.5	1.1	.2	.9	.5	.8	1.7	.9	.4	.7	1.2	1.9	-.2	+.6	-.3	+.8
4.5	.6	1.5	.4	.2	.7	.6	2.0	1.1	.4	.7	1.2	2.2	-.4	+.8	-.3	+1.0
5.0	.6	1.3	.3	.5	.7	.7	2.2	1.1	.4	.8	1.6	2.7	-.4	+.9	-.4	+1.2
5.5	.5	1.3	.2	.2	.6	.9	2.5	1.4	.5	.8	1.7	3.0	-.4	+1.0	-.5	+1.4

TEST WAS CONDUCTED WITHOUT ANY FAILURES.
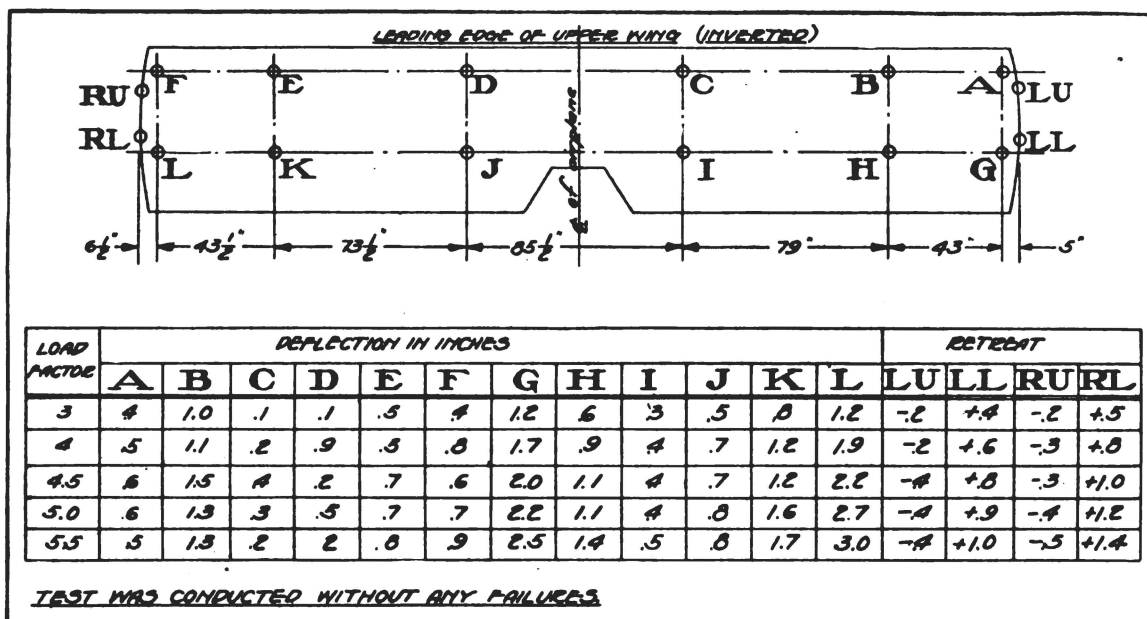
FIG. 14.—Tabulated results of the low angle of incidence static test of the Loening PA-1.

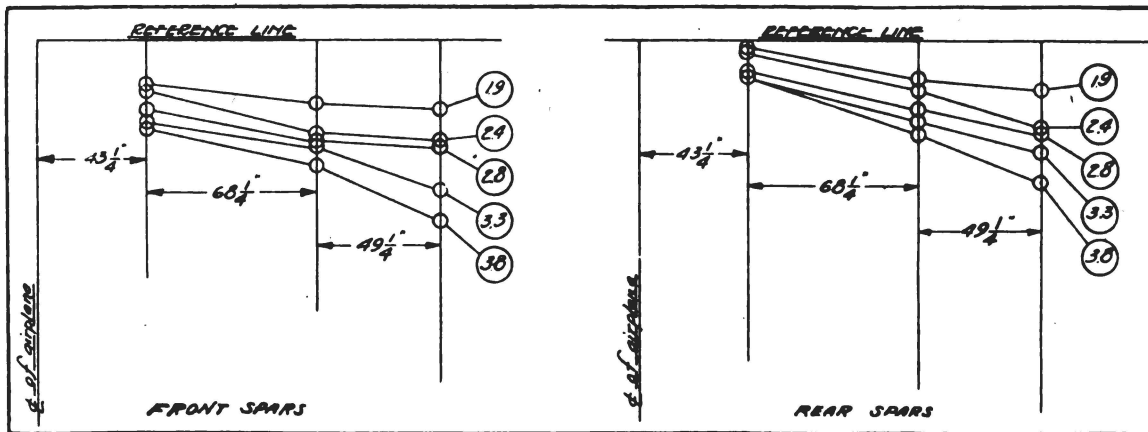FRONT SPARS   REAR SPARS

FIG. 15.—Curves showing mean deflection of the wing spars at points indicated during static test for low angle of incidence condition of the Loening PA-1.
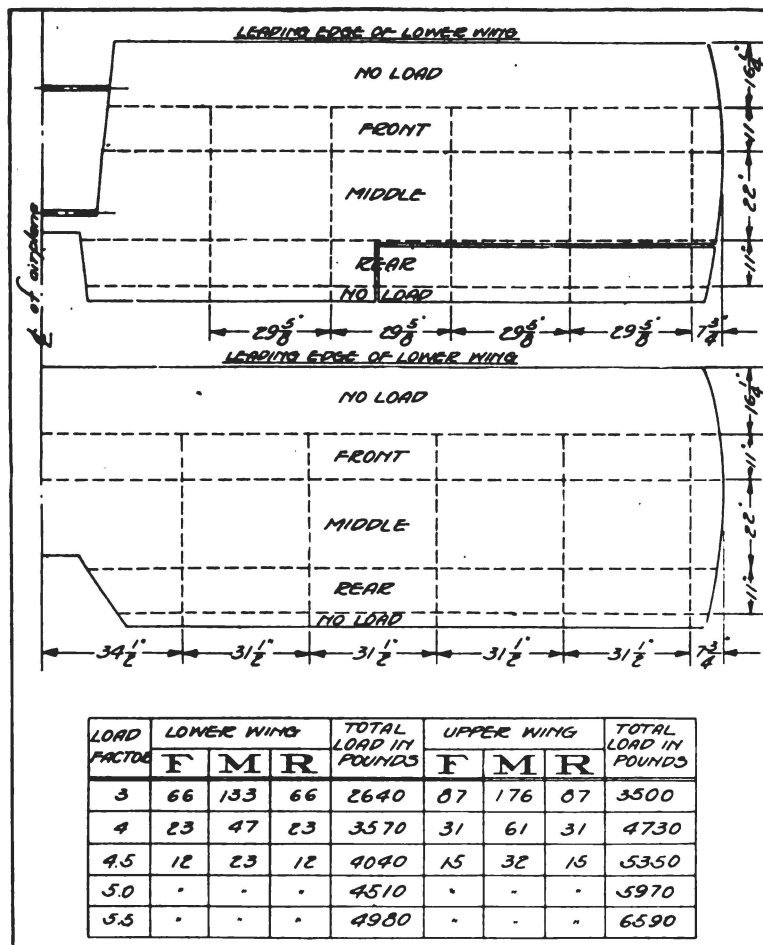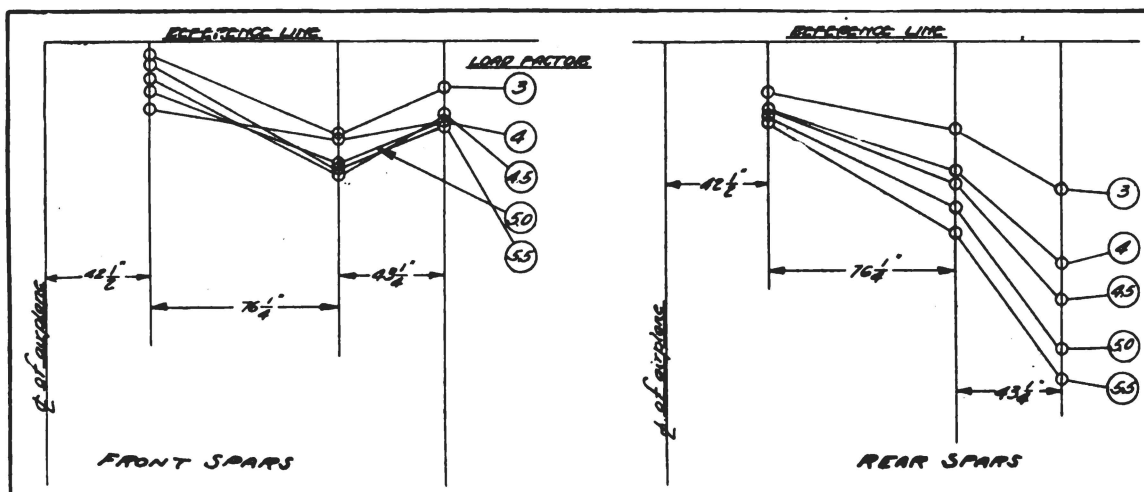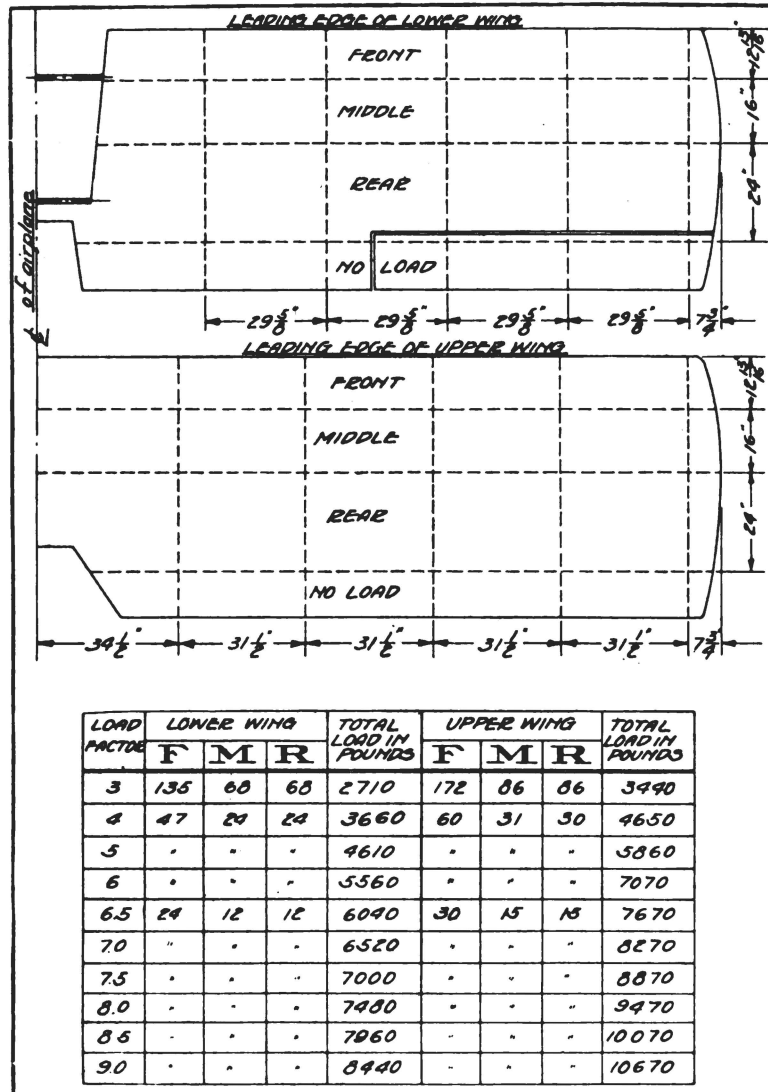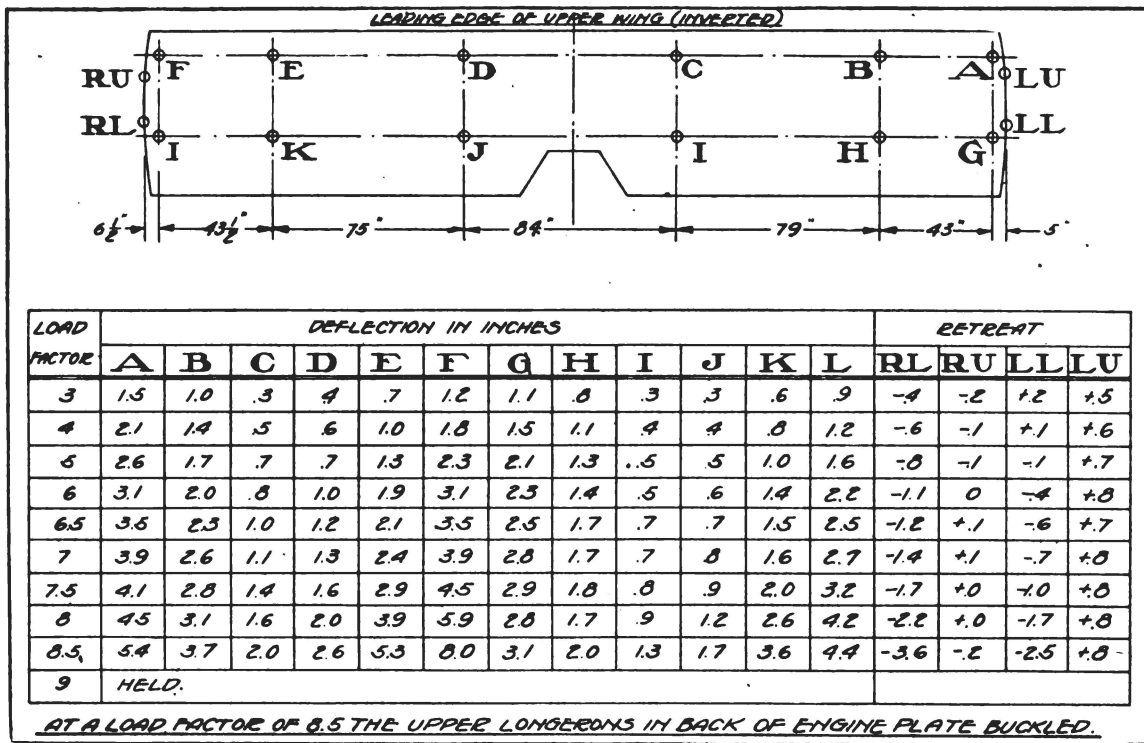
LEADING EDGE OF LOWER WING.

FRONT

MIDDLE

REAR

NO LOAD

LEADING EDGE OF UPPER WING.

FRONT

MIDDLE

REAR

NO LOAD

LOAD FACTOR	LOWER WING			TOTAL LOAD IN POUNDS	UPPER WING			TOTAL LOAD IN POUNDS
	F	M	R		F	M	R	
3	135	68	68	2710	172	86	86	3490
4	47	24	24	3660	60	31	30	4650
5	"	"	"	4610	"	"	"	5860
6	"	"	"	5560	"	"	"	7070
6.5	24	12	12	6040	30	15	15	7670
7.0	"	"	"	6520	"	"	"	8270
7.5	"	"	"	7000	"	"	"	8870
8.0	"	"	"	7480	"	"	"	9470
8.5	"	"	"	7960	"	"	"	10070
9.0	"	"	"	8440	"	"	"	10670

FIG. 16.

LOAD FACTOR	DEFLECTION IN INCHES												RETREAT			
	A	B	C	D	E	F	G	H	I	J	K	L	RL	RU	LL	LU
3	1.5	1.0	.3	.4	.7	1.2	1.1	.6	.3	.3	.6	.9	-.4	-.2	+.2	+.5
4	2.1	1.4	.5	.6	1.0	1.8	1.5	1.1	.4	.4	.8	1.2	-.6	-.1	+.1	+.6
5	2.6	1.7	.7	.7	1.3	2.3	2.1	1.3	..5	.5	1.0	1.6	-.8	-.1	-.1	+.7
6	3.1	2.0	.8	1.0	1.9	3.1	2.3	1.4	.5	.6	1.4	2.2	-1.1	0	-.4	+.8
6.5	3.5	2.3	1.0	1.2	2.1	3.5	2.5	1.7	.7	.7	1.5	2.5	-1.2	+.1	-.6	+.7
7	3.9	2.6	1.1	1.3	2.4	3.9	2.8	1.7	.7	.8	1.6	2.7	-1.4	+.1	-.7	+.8
7.5	4.1	2.8	1.4	1.6	2.9	4.5	2.9	1.8	.8	.9	2.0	3.2	-1.7	+.0	-1.0	+.8
8	4.5	3.1	1.6	2.0	3.9	5.9	2.8	1.7	.9	1.2	2.6	4.2	-2.2	+.0	-1.7	+.8
8.5	5.4	3.7	2.0	2.6	5.3	8.0	3.1	2.0	1.3	1.7	3.6	4.4	-3.6	-.2	-2.5	+.8
9	HELD.															

AT A LOAD FACTOR OF 8.5 THE UPPER LONGERONS IN BACK OF ENGINE PLATE BUCKLED.

FIG. 17.—Tabulated results of the high angle of incidence static test of the Loening PA-1.
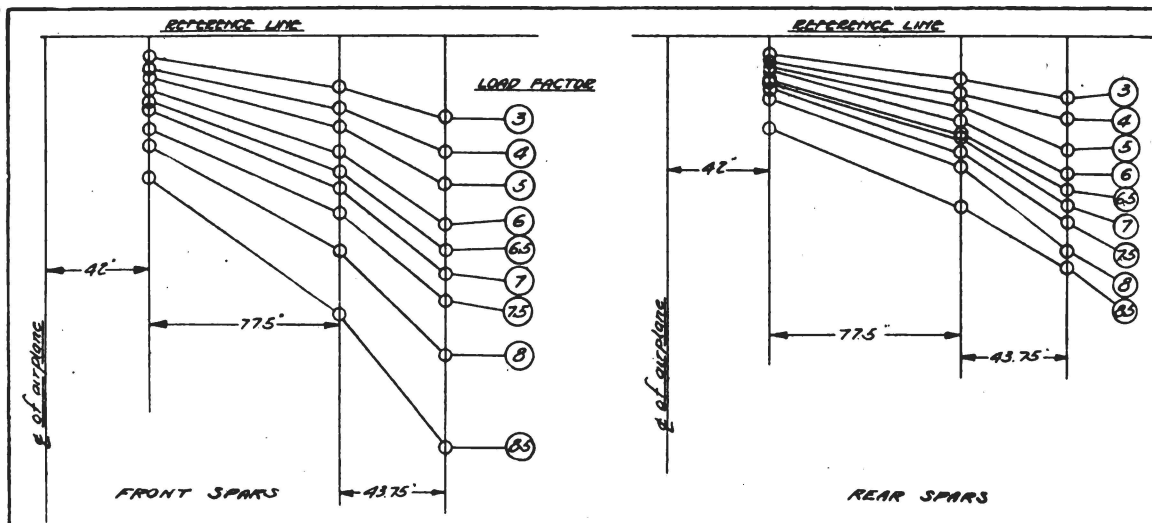

FIG. 18.—Curves showing mean deflection of the wing spars during static test for high incidence condition of the Loening PA-1.

The strength properties as computed from the test data are lower than the average for good spruce and the lower rear spar was exceedingly brash. The modulus of rupture as computed is as follows:

Spar.	Modulus of rupture pounds per square inch.
Lower rear.........	4,875
Upper rear.........	7,180
Lower front.......	7,270
Upper front.......	7,720

CONCLUSION.

The wing cellule passed the test satisfactorily.

PROCEDURE FOR TEST (LEADING EDGE).

A 6-foot section was cut from the upper wing after the static test of the cellule was complete. This section was supported in an inverted position, with points of support at the spars.

The load on the leading edge was counterbalanced by shot bags placed on the wing along the rear spar.

The factor of failure was computed as follows:

One-half of the load per running foot on the wing from which the section was taken, was considered the unit factor per running foot of the leading edge.

RESULTS.

The leading edge failed at a factor of 16.6 (Figs. 19 and 20).

CONCLUSION.

The leading edge stood the test satisfactorily, being 18 per cent stronger than the minimum requirements.

AILERONS.

DESCRIPTION.

The two ailerons are mounted on the lower wing by means of three hinges. The type of hinge is shown in Figure 21. Control is accomplished by means of flexible wire cables. Figure 22 shows the assembled framework and Figure 23 the type of rib and the control mast.

Each aileron has an area of 8.1 square feet and a weight of 6.125 pounds. (0.77 pounds per square foot).

PROCEDURE.

The aileron was assembled on the wing as for flight. A spring balance was connected to the control stick by means of which the pull necessary to actuate the aileron was measured.

RESULTS.

Load required 35 pounds per square foot.

At a load of 15 pounds per square foot the pulley brackets bent out of shape and showed signs of pulling away from the spar. The two ribs further out from the compression rib buckled. At 20 pounds per square foot the spar was distorted to such an extent that it split as shown in Figure 24. With the control system discontinued and a rigid connection made to the control mast, the loading was carried to 35 pounds per square foot without failure.

DISCUSSION.

Due to the spar failure it was impossible to finish testing the aileron with the control system connected.

CONCLUSION.

The spar is not strong enough. The pulley bracket and the location of the compression rib are unsatisfactory. The aileron is structurally as strong as required.

RECOMMENDATION.

Redesign the lower rear spars, the aileron control cable pulley bracket, and relocate the compression rib.

ELEVATOR AND STABILIZER.

DESCRIPTION.

The stabilizer is built around a routed spruce spar which supports plywood web ribs. The leading edge is cut from a piece of balsa wood. See Figure 22 for an assembly view of the framework and the two types of ribs. The stabilizer is adjustable.

A built-up spruce and balsa spar carries the ribs and diagonal balsa members which form the framework of the elevators. The balsa members are capped with three-ply plywood. The trailing edge is made from aluminum tubing terminating in the balsa wood end pieces. Figure 25 shows the structure of the elevators. The type of hinge used is shown in detail in Figure 21. Flexible steel cable controls are used. For the weight and area of the horizontal tail surfaces see Figure 26.

The elevator structure weighs 0.75 pounds per square foot and the stabilizer 0.95 pounds per square foot.

PROCEDURE.

The surfaces and control system were completely assembled as for flight. The fuselage was supported so that the longitudinal axis was horizontal. A spring balance with block and tackle attached to the control stick was used to measure the pull required to actuate the elevator under load. Scales were suspended from various points along the edge of the surfaces and by means of a wye level deflection readings were taken.

The load was applied in increments of 5 pounds per square foot up to and including 20 pounds per square foot and then in 2½ pounds increments until failure resulted. The average load per square foot on the elevator was assumed to be two-thirds the average load on the stabilizer. The stabilizer load was assumed to be uniform, and that on the elevators as varying from a maximum at the hinge to one-third maximum at the trailing edge, which results in a center of pressure location for unbalanced surfaces at five-twelfths of the mean chord.

RESULTS.

Stabilizer adjustment was possible up to and including a load of 10 pounds per square foot. At a load of 15 pounds per square foot the stabilizer adjustment could not be operated. The surfaces held the required average load of 35 pounds per square foot. The load was increased until the elevator failed at a load of 50 pounds per square foot. For tabulated deflection readings and the pull on the control stick required to actuate the elevator see
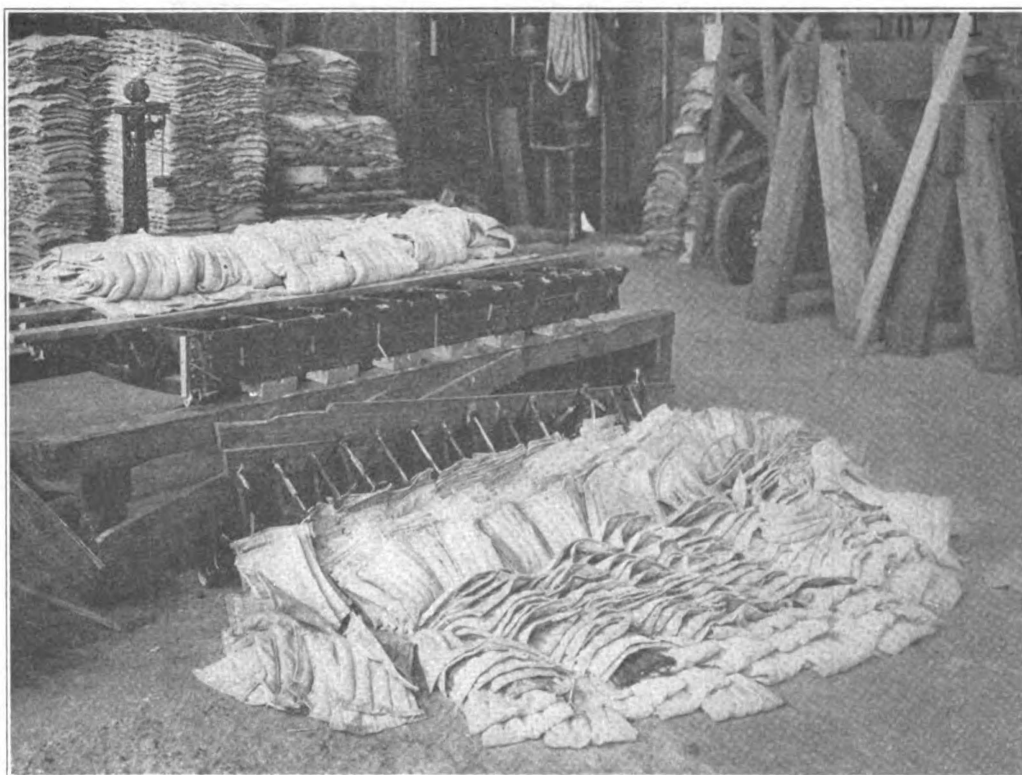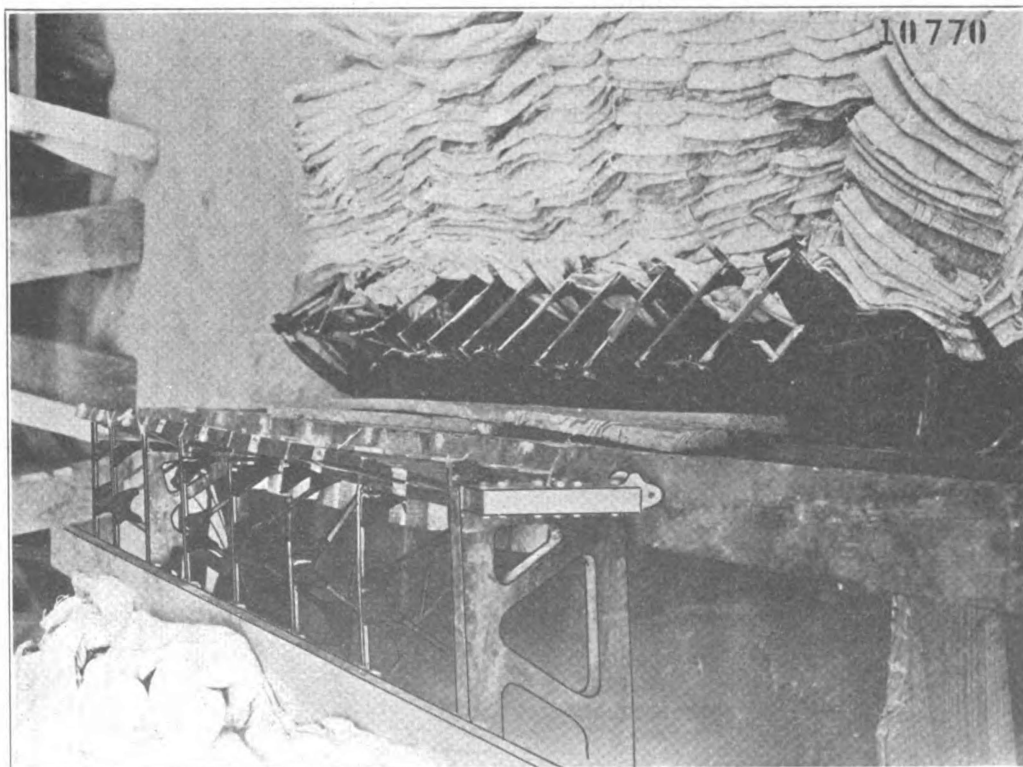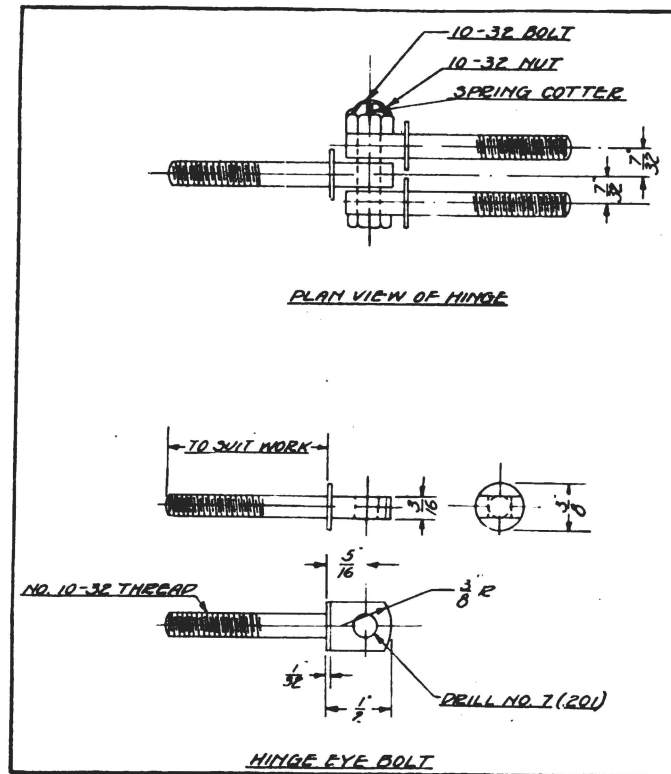
FIG. 19.

FIG. 20.

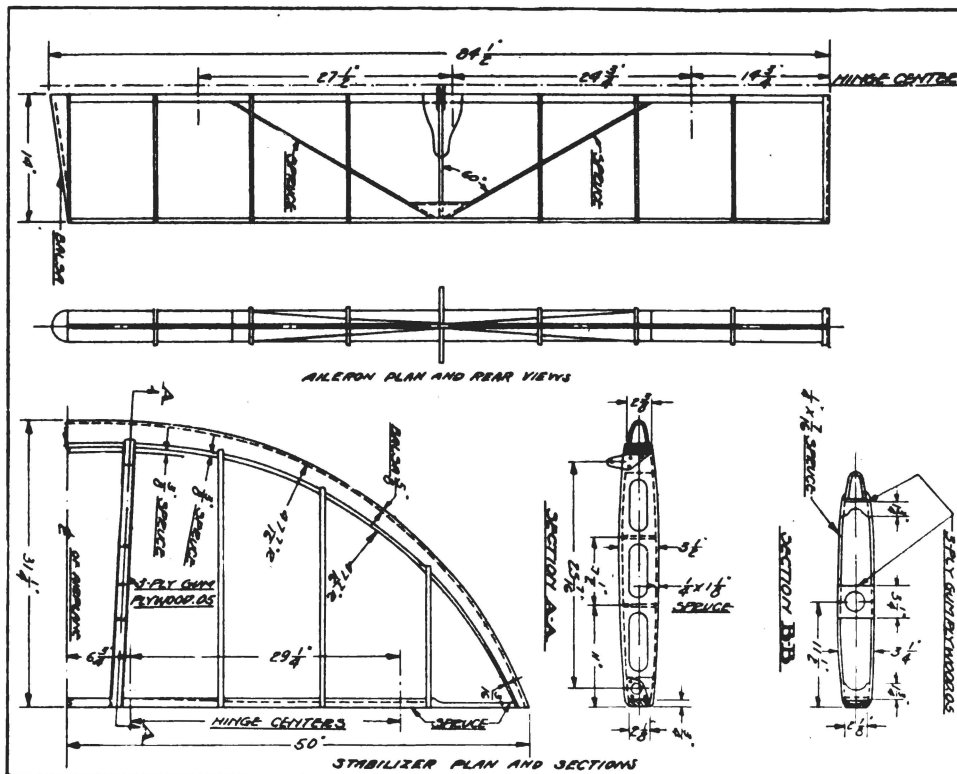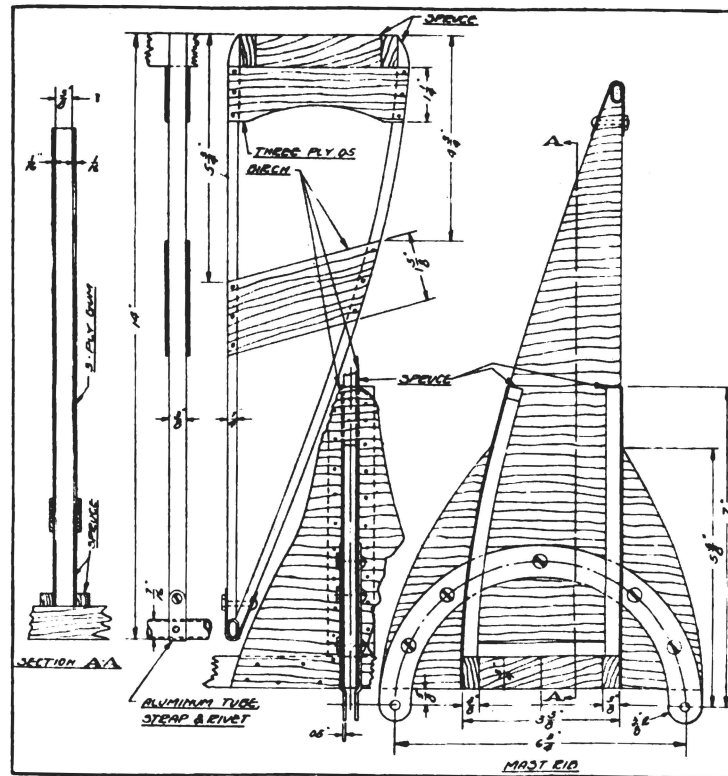Fig. 21.—Typical control surface hinge of the Loening PA-1.
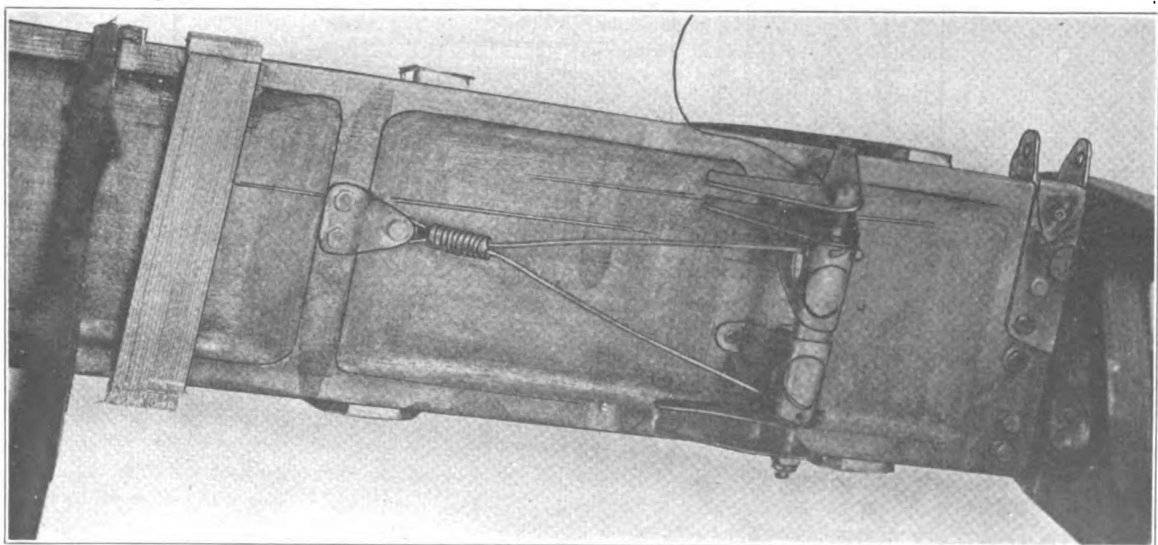

Fig. 22

FIG. 23.—Aileron ribs of the Loening PA-1.

FIG. 24.

FIG. 25.—Stabilizer of the Loening Airplane PA-1.

figure 26. The failure, with both sides of the elevator broken, is shown in figure 27.

CONCLUSION.

The horizontal tail surfaces and the control system are satisfactory.

RUDDER.

DESCRIPTION.

The balanced rudder is the only vertical tail surface. In terms of the total area of 8.1 square feet the balanced portion constitutes 14.4 per cent. The structural members are of mild steel tubes welded together. The lower part of the rudder fairs in with the rear of the fuselage. Control is obtained by means of flexible steel cables from the rudder bar to the control cable masts. Figure 28 is an assembly of the rudder framework.

PROCEDURE.

The rudder was assembled to the fuselage as for flight. To one end of the rudder bar the control cable was connected, to the other a spring balance with block and tackle by means of which the force necessary to actuate the rudder under load was obtained. The fuselage was firmly supported on its side so that it would not tip over. At the points indicated in figure 29 scales were suspended in order that the deflection readings could be taken by means of a wye level. The balanced portion is loaded one and one-half times the average load per square foot on the unbalanced portion. The load on the unbalanced portion is distributed in the same manner as that on the elevator.

RESULTS.

The rudder supported the required load of 30 pounds per square foot without failure. The loading was continued until failure of the ribs resulted at 47.5 pounds per square foot. Figure 29 gives the pull necessary to actuate the rudder under load and the deflection of the surfaces at the points indicated. Figure 30 is a photograph of the rudder failure with the fabric cover removed.

CONCLUSION.

The rudder and the controls held the required load satisfactorily.

FUSELAGE.

DESCRIPTION.

The all-metal fuselage has four steel tubular longerons. The ends of the tubular compression struts are inserted in holes cut through the wall of the longerons, as shown in figure 31. The brace wires are wrapped around the tubular members and drawn tight by means of turnbuckles. Figure 31 shows the structural assembly and a typical joint between a compression strut and longeron. The engine bearer is formed from a three-sixteenth inch sheet of aluminum and the rear end plate of the fuselage is made from the same material.

The fuselage weights follow:

	Pounds.
Fuselage structure, including engine bearer and end plate	92.5
Cowling and fairing	17.5
Furnishings	28.9
Total weight of fuselage	138.9

PROCEDURE.

The fuselage was supported in a test jig at the points where the flying wires connect to the spars. After these points had been loaded to their carrying capacity, points where the wings are attached to the fuselage were used as additional supports.

The load was applied at five points, A to E, inclusive, figure 32, according to the loading schedule. Scales were suspended from four points, figure 32, from which deflection readings were taken by means of a wye level. The load increments were supported for five minutes before readings were taken.

RESULTS.

When the jacks were let down at a load factor of 4, the right upper wing spars failed in compression, the ribs failed in compression, and a drift wire pulled in two. A load factor of 7.5 was supported for three minutes, when a wire in the second to the last bay, left side, failed. The wire was replaced, and after supporting a factor of 8 for five minutes failed again. With a three-sixteenth inch flexible steel cable in place of the wire the test was continued. The lower longerons buckled in the third bay from the tail end, at a factor of 8. Figure 33 is a photograph of this failure.

DISCUSSION.

Two longerons were sent to the Material Section for physical and chemical tests. The following results received:

	(1)		(2)
Yield point	60,280		53,790
Ultimate strength	69,660		69,910
Elongation in 2 in.	19%		19%
Elongation in 4 in.	13%		13.75%
Elongation in 8 in.	8.38%		12.25%

Chemical composition.

Speci-men.	Carbon.	Manganese.	Phos-phorus.	Sulphur.
(1)	0.18–0.18	0.35–0.38	0.030	0.051
(2)	.10– .12	.49	.030	.038

CONCLUSION.

The fuselage stood the required load factor of 7 satisfactorily.

LANDING CHASSIS.

DESCRIPTION.

The landing chassis has spruce struts and spruce cross struts. The cross struts carry the axle fairing. The method of wrapping the shock absorber chord is shown in figure 34, and also the arrangement of the struts and

	WEIGHT IN LBS	AREA IN SQ. FT
STABILIZER	13.0	13.6
ELEVATOR	9.5	12.6

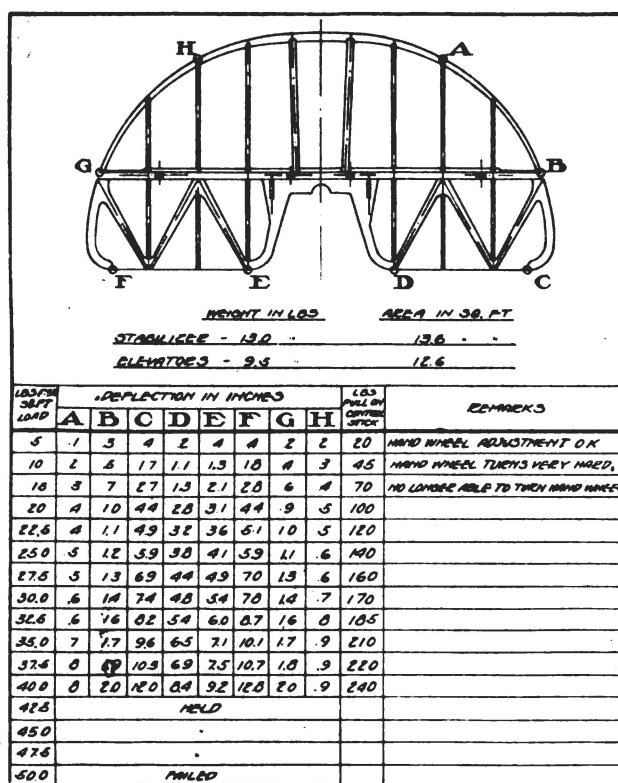| LBS PER SQ FT LOAD	DEFLECTION IN INCHES								LBS PULL ON CONTROL STICK	REMARKS
	A	B	C	D	E	F	G	H		
5	.1	.3	.4	.2	.4	.4	.2	.2	20	HAND WHEEL ADJUSTMENT OK
10	.2	.6	1.7	1.1	1.3	1.8	.4	.3	45	HAND WHEEL TURNS VERY HARD,
15	.3	.7	2.7	1.3	2.1	2.8	.6	.4	70	NO LONGER ABLE TO TURN HAND WHEEL
20	.4	1.0	4.4	2.8	3.1	4.4	.9	.5	100	
22.5	.4	1.1	4.9	3.2	3.6	5.1	1.0	.5	120	
25.0	.5	1.2	5.9	3.8	4.1	5.9	1.1	.6	140	
27.5	.5	1.3	6.9	4.4	4.9	7.0	1.3	.6	160	
30.0	.6	1.4	7.4	4.8	5.4	7.8	1.4	.7	170	
32.5	.6	1.6	8.2	5.4	6.0	8.7	1.6	.8	185	
35.0	.7	1.7	9.6	6.5	7.1	10.1	1.7	.9	210	
37.5	.8	1.9	10.9	6.9	7.5	10.7	1.8	.9	220	
40.0	.8	2.0	12.0	8.4	9.2	12.8	2.0	.9	240	
42.5	HELD									
45.0										
47.5										
50.0	FAILED									

FIG. 26.—Tabulated results of the static tests of the Loening PA-1 elevators and stabilizers.

FIG. 27.

Fig. 28.—Rudder.

WEIGHT – 25⁶   AREA OF BALANCED PORTION - 1.17 SQ. FT.
TOTAL AREA - 8.1 SQ. FT.

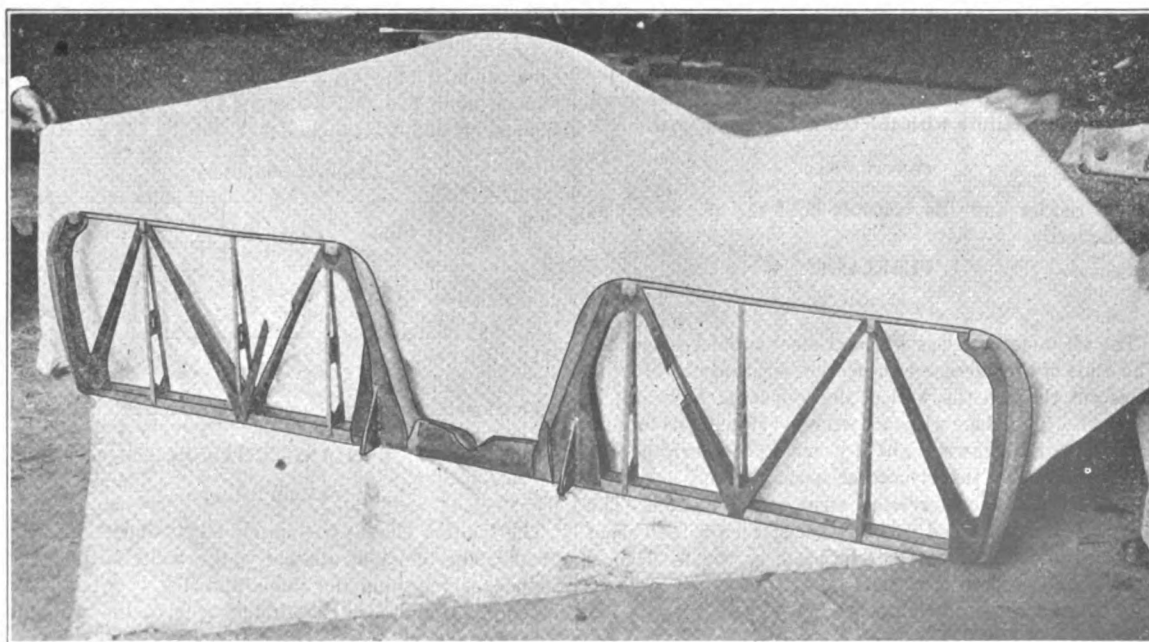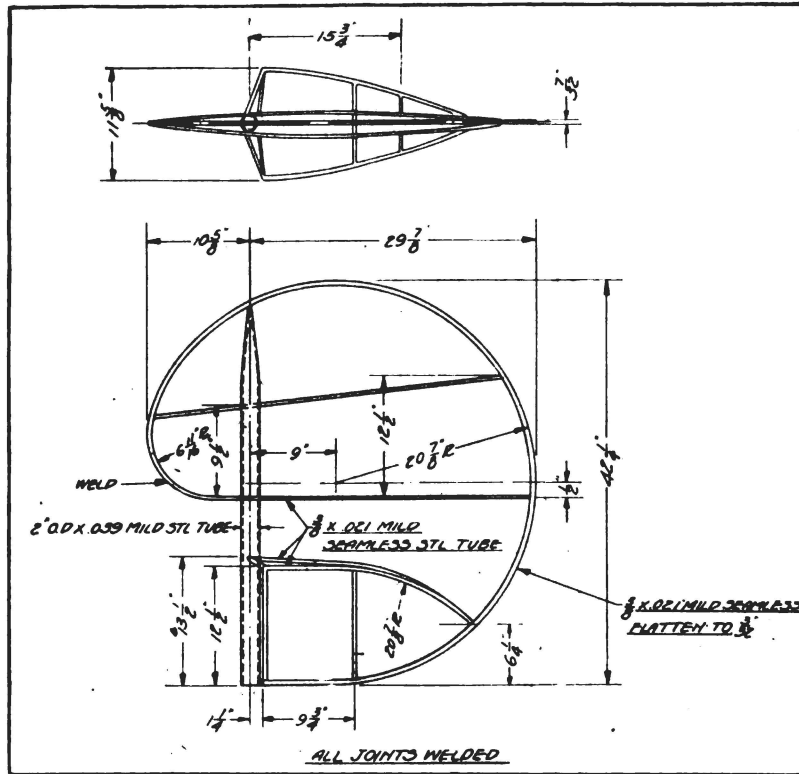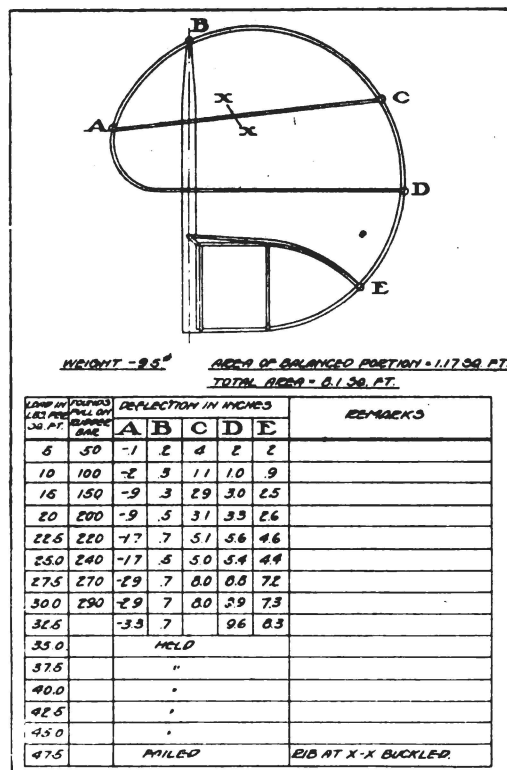| LOAD IN POUNDS LBS. PER SQ. FT.	POUNDS PULL ON RUDDER BAR	DEFLECTION IN INCHES					REMARKS
		A	B	C	D	E	
5	50	-.1	.2	.4	.2	.2	
10	100	-.2	.3	1.1	1.0	.9	
15	150	-.9	.3	2.9	3.0	2.5	
20	200	-.9	.5	3.1	3.3	2.6	
22.5	220	-.17	.7	5.1	5.6	4.6	
25.0	240	-.17	.5	5.0	5.4	4.4	
27.5	270	-.29	.7	8.0	8.8	7.2	
30.0	290	-.29	.7	8.0	3.9	7.3	
32.5		-.33	.7		9.6	8.3	
35.0		HELD					
37.5		"					
40.0		"					
42.5		"					
45.0		"					
47.5		FAILED					RIB AT X-X BUCKLED.

Fig. 29.—Tabulated results of the static test of the rudder on
the Loening PA-1.

FIG. 30

FIG. 31.—Fuselage—Loening PA-1.

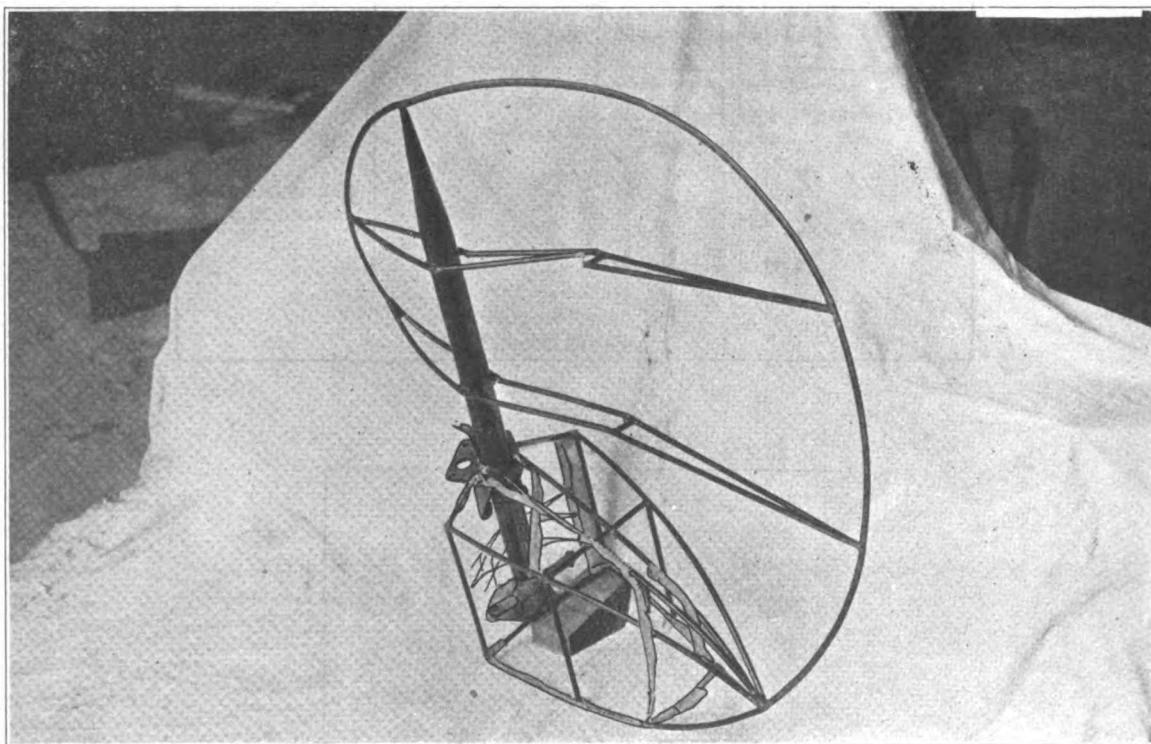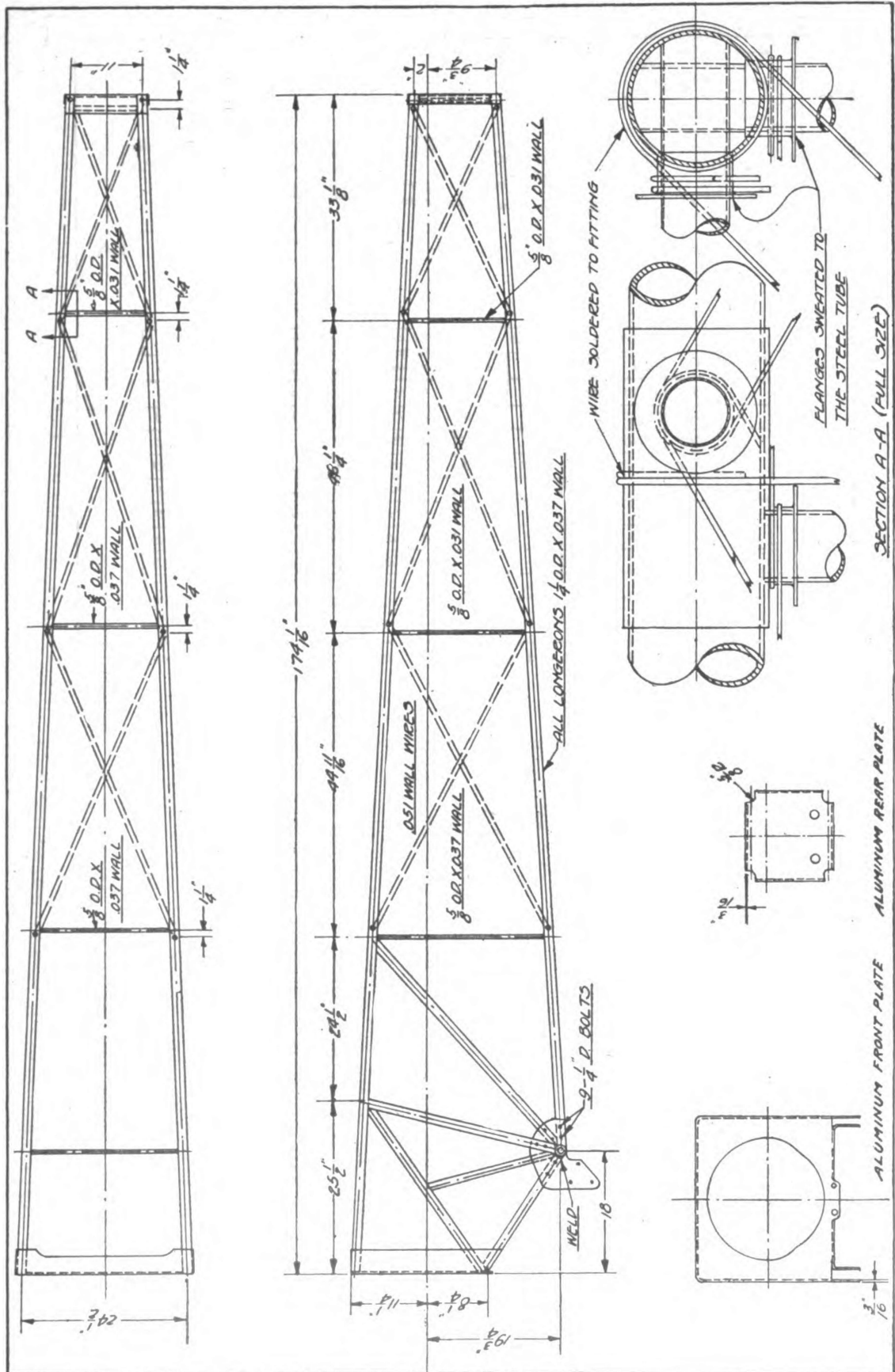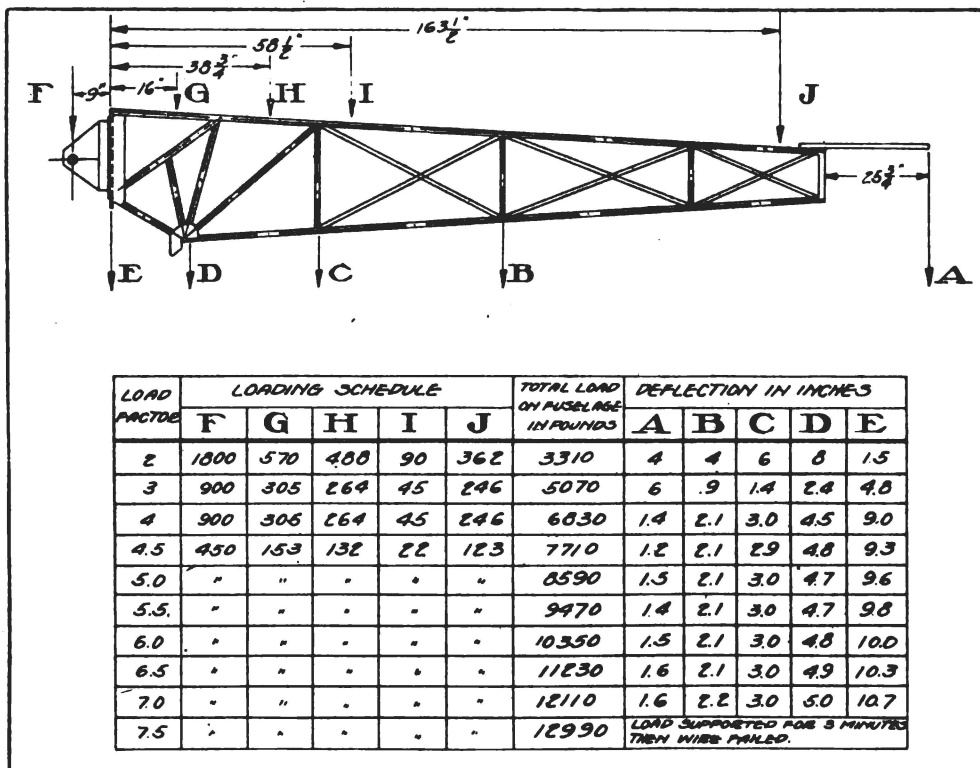| LOAD FACTOR	LOADING SCHEDULE					TOTAL LOAD ON FUSELAGE IN POUNDS	DEFLECTION IN INCHES				
	F	G	H	I	J		A	B	C	D	E
2	1800	570	488	90	362	3310	4	4	6	8	1.5
3	900	305	264	45	246	5070	6	.9	1.4	2.4	4.8
4	900	306	264	45	246	6830	1.4	2.1	3.0	4.5	9.0
4.5	450	153	132	22	123	7710	1.2	2.1	2.9	4.8	9.3
5.0	"	"	"	"	"	8590	1.5	2.1	3.0	4.7	9.6
5.5	"	"	"	"	"	9470	1.4	2.1	3.0	4.7	9.8
6.0	"	"	"	"	"	10350	1.5	2.1	3.0	4.8	10.0
6.5	"	"	"	"	"	11230	1.6	2.1	3.0	4.9	10.3
7.0	"	"	"	"	"	12110	1.6	2.2	3.0	5.0	10.7
7.5	"	"	"	"	"	12990	LOAD SUPPORTED FOR 3 MINUTES THEN WIRE FAILED.				

FIG. 32.—Loading schedule and chart of deflections of the Loening PA-1 fuselage during static test.
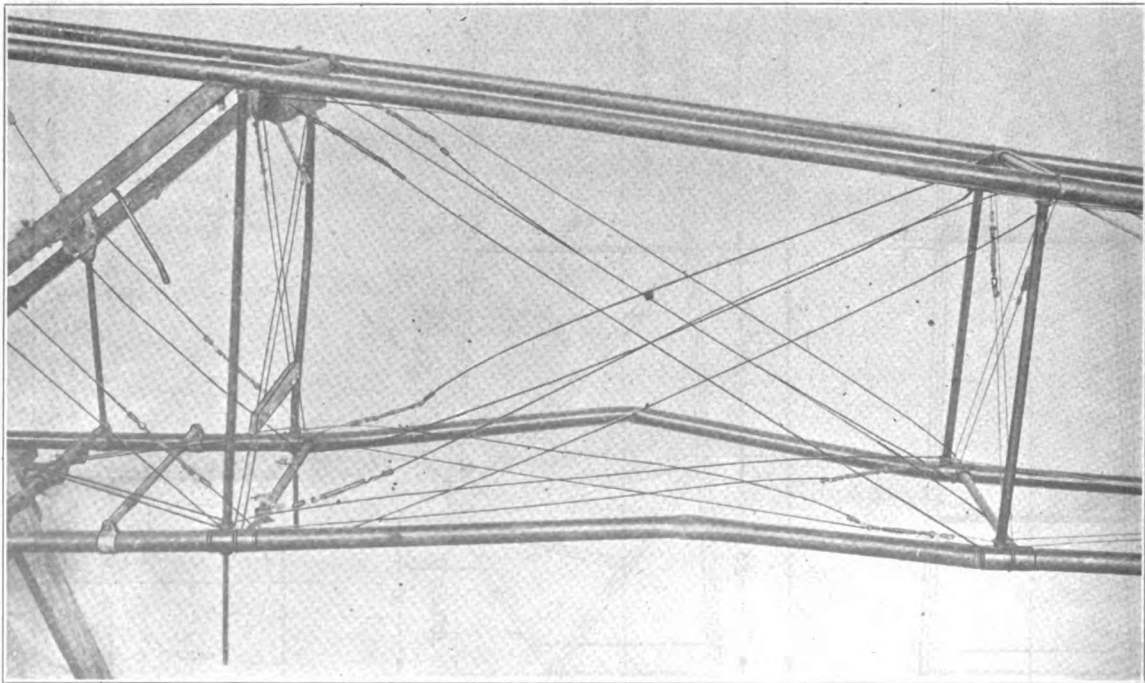
FIG. 33.
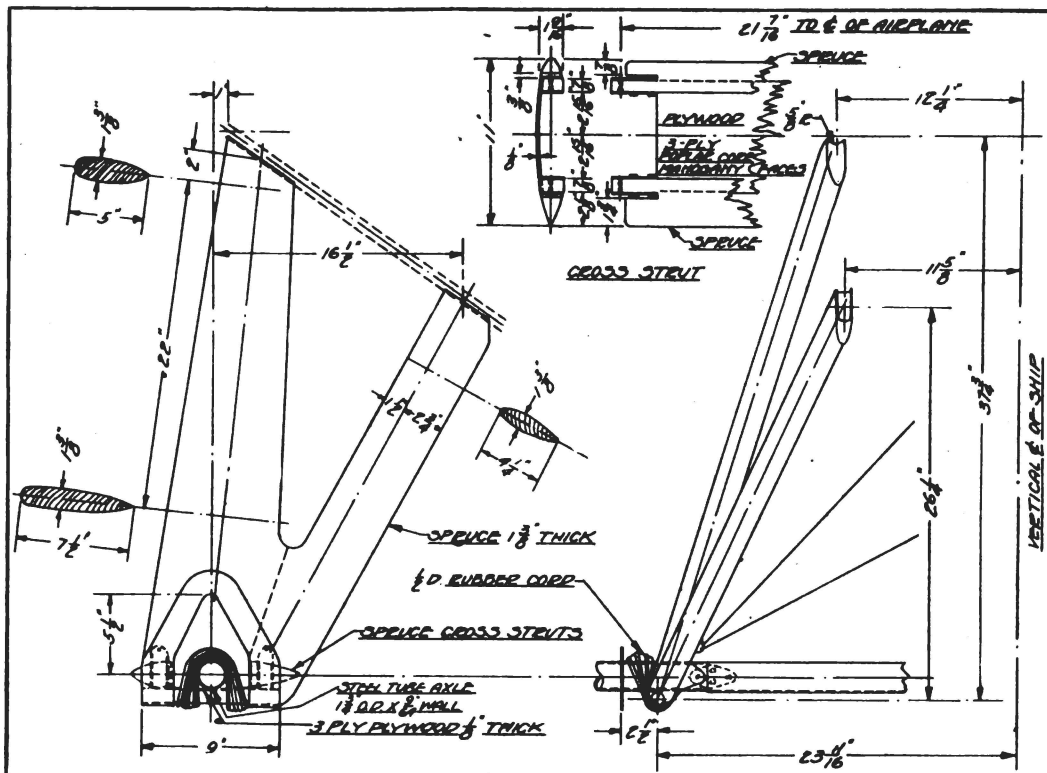
FIG. 34.—Chassis—Loening PA-1.

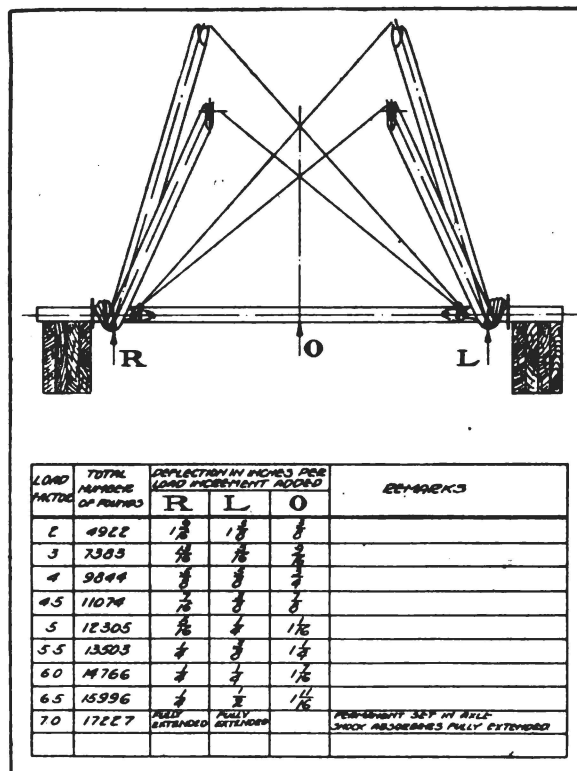| LOAD FACTOR	TOTAL NUMBER OF POUNDS	DEFLECTION IN INCHES PER LOAD INCREMENT ADDED			REMARKS
		R	L	O	
2	4922	1½	1⅜	⅝	
3	7383	⅝	⅝	¾	
4	9844	½	½	½	
4.5	11074	⁵⁄₁₆	½	½	
5	12305	⁷⁄₁₆	½	1⅛	
5.5	13503	½	⅜	1¼	
6.0	14766	¼	¼	1⅛	
6.5	15996	¼	I	1¹¹⁄₁₆	
7.0	17227	FULLY EXTENDED	FULLY EXTENDED		PERMANENT SET IN AXLE SHOCK ABSORBERS FULLY EXTENDED

FIG. 35.—Static test results of the Loening PA-1 landing chassis.

their sections at points indicated. The weight of the chassis without wheels is 43.9 pounds. Weight of wheels, 31 pounds.

PROCEDURE.

With the axle in a horizontal position, the chassis was placed in a jig so that a vertical line passed through the center of the axle and the center of gravity of the airplane. The airplane was represented by the load placed on the test jig platform. The wheels were removed and the bearing portion of the axle placed on blocks which supported the landing chassis. Deflections of the shock absorbers and bending of the axle were taken for each load increment after it had been supported for five minutes.

RESULTS.

Tabulated results are given in figure 35. The axle showed a permanent set, and the shock absorber chord was fully extended at a load factor of 6.5 The struts held a load factor of 7 without failure.

CONCLUSION.

The landing chassis held the required load factor of 6 satisfactorily.

○